

TECHNOLOGY UTILIZATION

**VALVES AND OTHER MECHANICAL COMPONENTS
AND EQUIPMENT**

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A COMPILATION



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Foreword

The National Aeronautics and Space Administration has established a Technology Utilization Program for the dissemination of information on technological developments which have potential utility outside the aerospace community. By encouraging multiple application of the results of its research and development, NASA earns for the public an increased return on the investment in aerospace research and development programs.

Compilations are now published in nine broad subject groups:

SP-5971: Electronics - Components and Circuitry	SP-5976: Mechanics
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SP-5973: Physical Sciences	SP-5978: Fabrication Technology
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SP-5975: Life Sciences	

When the subject matter of a particular Compilation is more narrowly defined, its title describes the subject matter more specifically. Successive Compilations in each broad category above are identified by an issue number in parentheses: e.g., the (03) in SP-5972 (03).

The articles in this Compilation will be of interest to mechanical engineers, users and designers of machinery, and to those engineers and manufacturers specializing in fluid handling systems. Section 1 describes a number of valves and valve systems. Section 2 contains articles on machinery and mechanical devices that may have applications in a number of different areas.

Additional technical information on items in this Compilation can be requested by circling the appropriate number on the Reader Service Card included in this Compilation.

The latest patent information available at the final preparation of this Compilation is presented on page 30. For those innovations on which NASA has decided not to apply for a patent, a Patent Statement is not included. Potential users of items described herein should consult the cognizant organization for updated patent information at that time.

We appreciate comment by readers and welcome hearing about the relevance and utility of the information in this Compilation.

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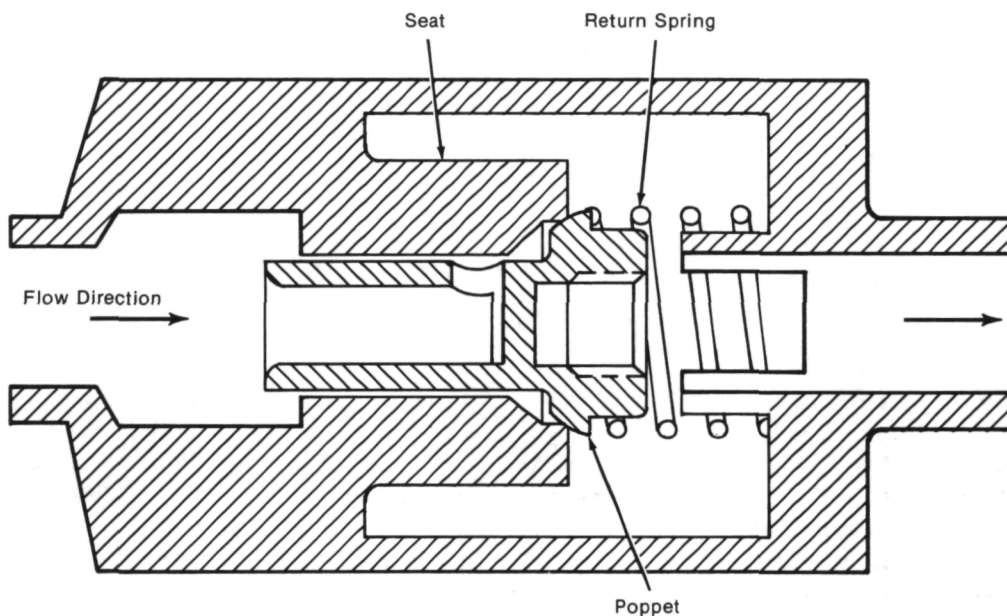
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Contents

	Page
SECTION 1. VALVES	
Check Valve With Pneumatically Side-Loaded Poppet	1
All-Metal Butterfly-Valve Seat	2
Butterfly-Valve Seat-Lifting Device	3
Low-Cost Shutter Valve for High Temperatures and Pressures	4
Fastening a Tungsten-Carbide Valve Poppet to an Inconel-718 Flexure Disk	5
Valve-Seat Seal for a Latching Solenoid Valve	6
Dual-Pushbutton Pressure-Equalization Valve	7
Magnetic Latching Valve	8
Dual-Direction Flow-Balanced Poppet	10
High-Temperature Valves for Liquid-Metal Systems	12
Latching Solenoid Valve (Belleville Latch Concept)	14
SECTION 2. MACHINERY, EQUIPMENT, AND MECHANICAL DEVICES	
Redundant Screwjack	15
Electromechanical Torque-Limiting Coupling	16
Frictionless Roll-Flex Pivot	17
Mechanical Coupling for High-Cyclic Loading	18
Improved Laboratory Gradiometer Can Be a Field Survey Instrument	19
A Device for Declogging Hoppers	20
Programable Remote-Control Soil Sampler	21
A Technique for Centering Lockwashers on High-Speed Rotating Equipment	22
Pressure-Activated Tool Release and Locking Mechanism	23
Magnetic Particle Clutch Controls Servo System	24
Jeweler's Collet Adapter for Toolroom Lathe	25
Spiral Machining by Tape Control	26
High-Speed Power-Drive Unit Adapted to Numerical-Control Drill	27
Photosensor Guard for Papercutter Clamp	28
PATENT INFORMATION	30

Section 1. Valves

CHECK VALVE WITH PNEUMATICALLY SIDE-LOADED POPPET



Check Valve With Pneumatically Side-Loaded Poppet

A poppet valve that eliminates chattering at metal-to-metal faces will interest designers of fluid flow systems. A check valve that was designed for an oxygen system, to prevent loss of system pressure, is illustrated in the drawing. This is a seat/poppet combination with excellent seal and wear characteristics. If this poppet were undamped, it would strike the highly resilient seat and cause severe chattering. Conventional damping techniques either employ materials not compatible with many valve systems, or are quite complex.

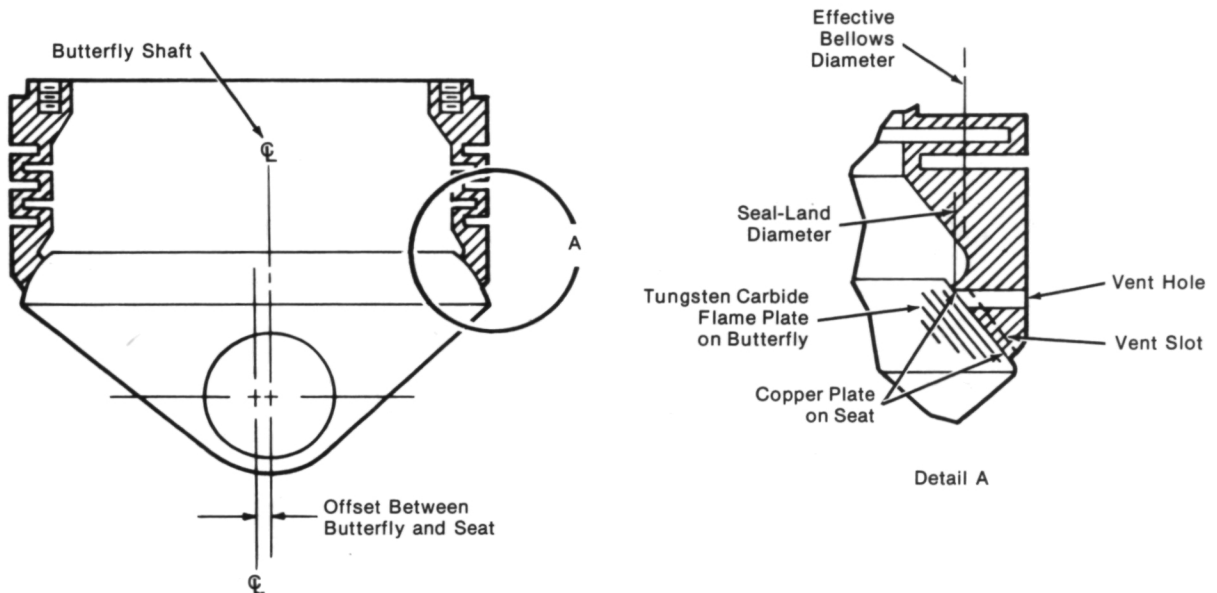
Using the design shown in the figure, the poppet can be damped and the chattering eliminated by side loading the poppet. This increases the frictional force between poppet stem and guide. The poppet is side

loaded by having the gas enter the poppet stem axially, upstream of the guide, but leave radially, downstream of the guide. This motion pushes the poppet stem against its guide. Side load increases as the flow increases, providing maximum damping at high flows; side load will be zero at no flow.

Source: J. F. Sheehan of
Grumman Aerospace Corp.
under contract to
Johnson Space Center
(MSC-12535)

No further documentation is available.

ALL-METAL BUTTERFLY-VALVE SEAT



All-Metal Butterfly-Valve Seat

A seal for a butterfly-valve closure has been designed for high-pressure hydrogen. The seal consists of a metal bellows with a copper-plated seat on one end, machined as an integral part of the bellows (see figure). The seat of the butterfly is flame plated with tungsten carbide and is diamond lapped on a spherical diameter to match the seat.

Electrodeposited copper, baked to a hardness of RB60 and precision lapped to match the spherical seat, provides a wear-resistant metallic seal. The seal is installed in the inlet side of the valve and is pressure loaded by the bellows, to increase seat loading at high inlet pressures. The relatively wide seat accommodates large-seat loads at high inlet pressures, but the actual sealing land is confined to a narrow lip at the upper edge. The sealing land is accurately controlled to a diameter slightly smaller than the effective bellows diameter, and the bearing area is vented downstream through radial holes and slots.

The bellows are spring preloaded, to maintain a seal at low pressures. This compensates for misalignment and structural or thermal deflections between the seal and the butterfly. A slight offset between the seat and the shaft centers allows the butterfly to separate from the seal as the valve opens. This reduces the high-seal contact stresses, which occur with the valve partially open. The innovation may interest fluid-control manufacturers.

Source: T. W. Rose of
Rockwell International Corp.
under contract to
NASA Headquarters
(HQN-10675)

No further documentation is available.

BUTTERFLY-VALVE SEAT-LIFTING DEVICE

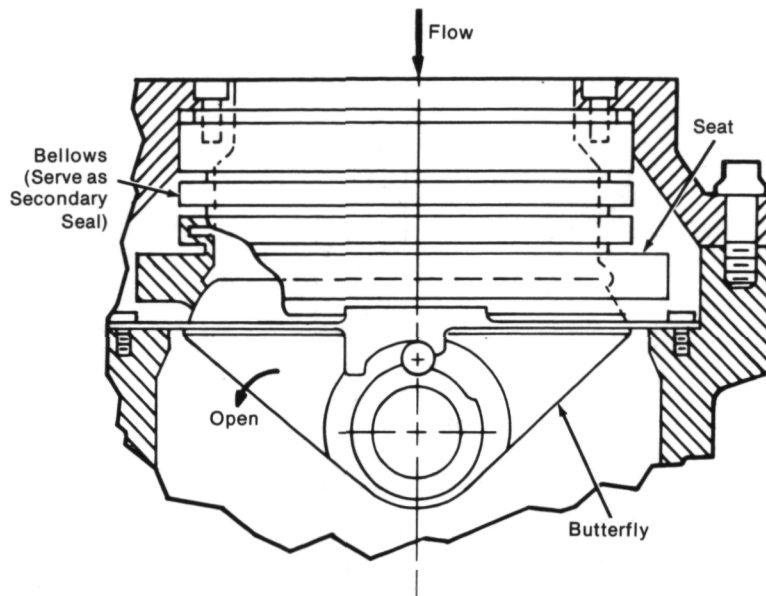
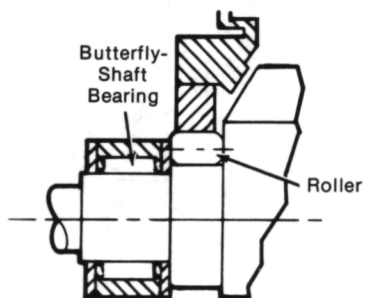


Figure 1. Valve Closed



Section A-A

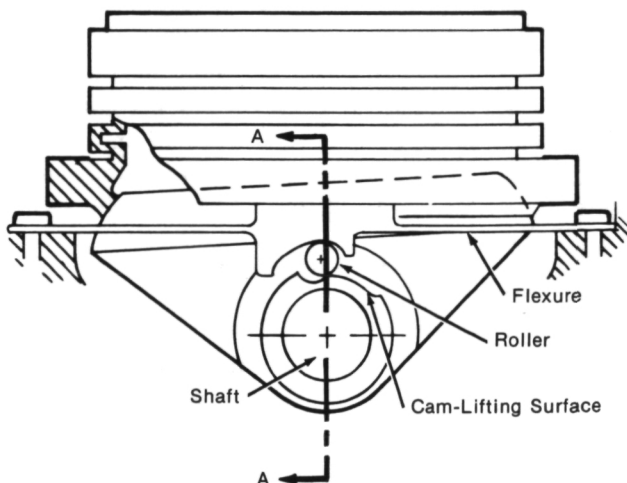


Figure 2. Valve As Opening

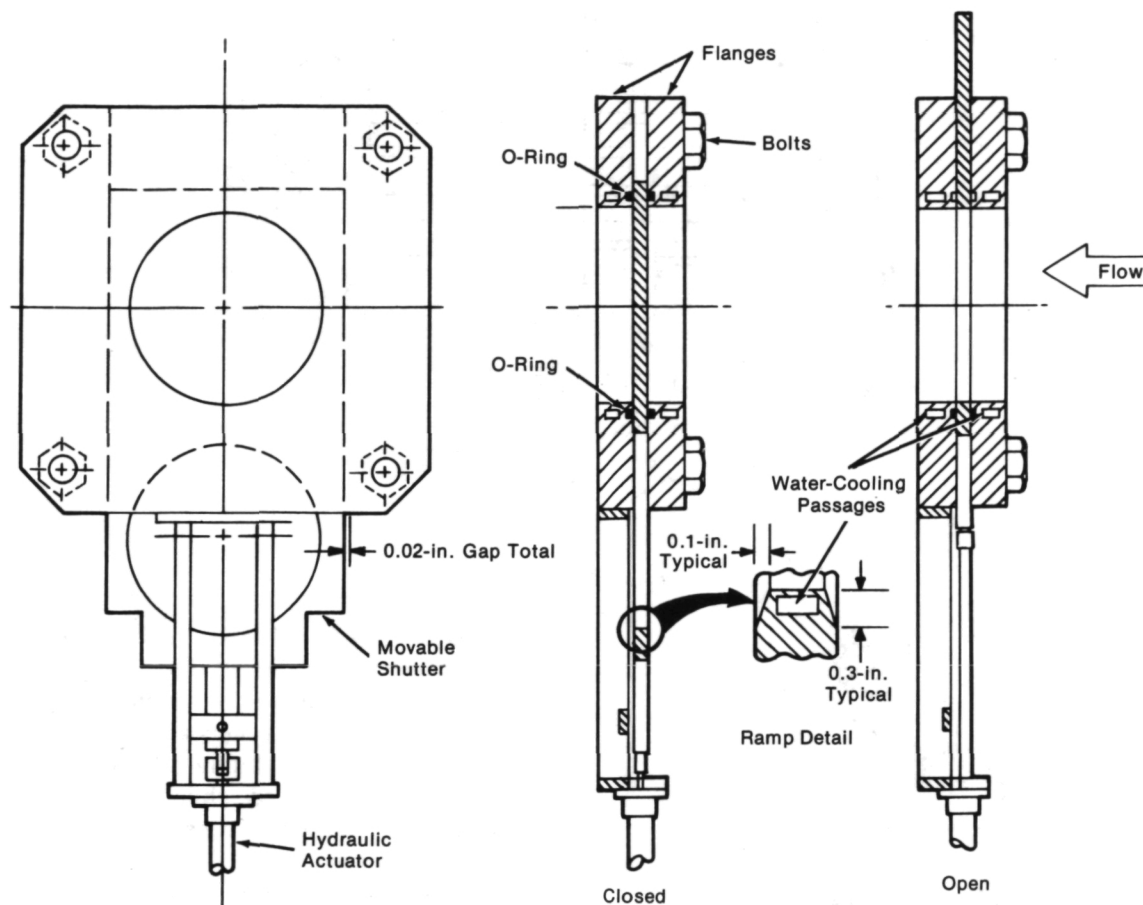
In order to prevent seal wear, the butterfly seat of a butterfly-type valve can lift off the mating seal before rotation. This innovation is shown in the figures. As the valve opens, a pair of rollers and cams lift the seal off the butterfly seat. A sliding motion between seal and butterfly is permitted while the seal is in full contact with the butterfly, because bearing stresses are low at this time.

The cam-lifting surfaces (one on each shaft) are an integral part of the butterfly; they provide precision in timing to cause the seal to be lifted by small increments of shaft rotation. A single roller on each cam lifts the seal with a mating load-bearing member, which is mounted flexurally to the valve housing. The flexure member isolates the seal from lateral loads, imparting a lifting motion to the seal and maintaining a preload on the rollers when the valve is closed; this keeps the rollers in their proper location.

Source: T. W. Rose of
Rockwell International Corp.
under contract to
NASA Headquarters
(HQN-10676)

No further documentation is available.

LOW-COST SHUTTER VALVE FOR HIGH TEMPERATURES AND PRESSURES



Low-Cost Shutter Valve for High Temperature and Pressure

A simplified shutoff valve has been designed for use at high temperatures and pressures. The valve does not require a conventional bonnet; it is sealed by two O-rings compressed by a sliding shutter, which opens or closes passage through the valve (see figure).

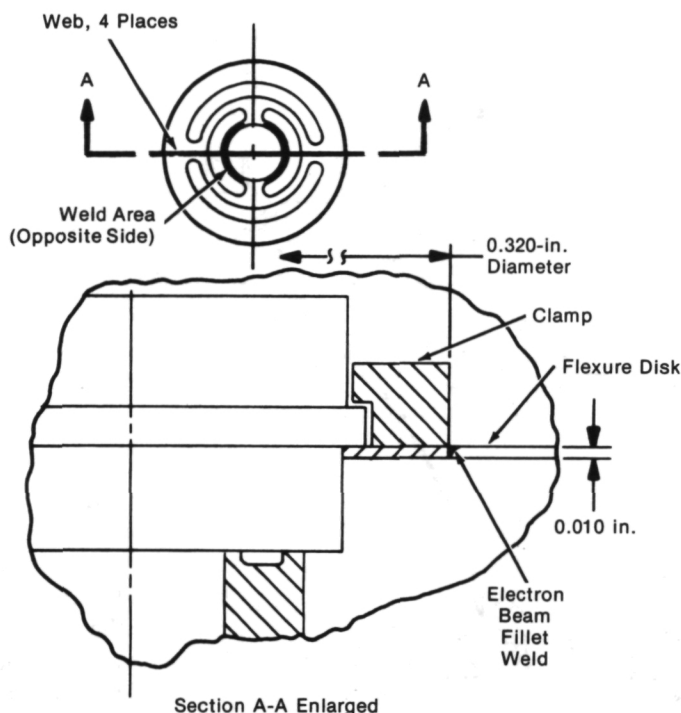
This valve is in use in a pipeline 46 cm (18 in.) in diameter, carrying nitrogen at the rate of 58 kg/s (128 lb/s), at 250 K (-10° F), and 8.3×10^6 N/m² (1200 psig). The valve is installed by bolting its flanges to existing flanges in the line. Maximum operating temperature for the valve is 615 K (650° F). Both the valve and the pipeline are water cooled.

The valve is constructed of carbon steel, and the parts are electroless-nickel-plated to prevent corrosion. The fluorocarbon O-rings are 1.27 cm (0.5 in.) in diameter. The edges of the opening in the shutter are ramped to eliminate sharp edges and to protect the O-rings. Both the shutter and the O-rings are coated with a solid lubricant (MoS₂). A cushioned hydraulic actuator operates the shutter.

Source: George A. Pinkas
Lewis Research Center
(LEW-11853)

Circle 1 on Reader Service Card.

FASTENING A TUNGSTEN-CARBIDE VALVE POPPET TO AN INCONEL-718 FLEXURE DISK



Fastening A Tungsten Carbide Valve Poppet
To An Inconel-718 Flexure Disk

Flexure disks have been used in some valve assemblies to reduce vibration-induced radial motion and wear between seats and poppets. The poppet was attached to the flexure disk, and axial compliance of the flexure disk permitted poppet motion in the axial direction, while flexure-disk stiffness in nonaxial directions restrained the poppet from radial motion. The methods of fastening the poppet to the flexure disk have included the use of retaining rings and interference kits. The resulting system, however, was not reliable with these methods.

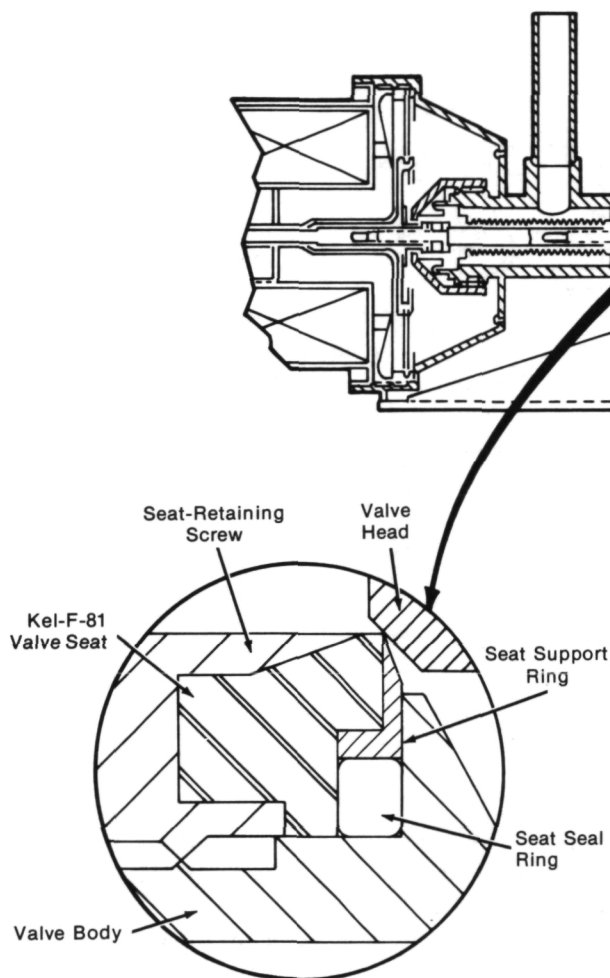
Flexure disks may range in thickness from 0.005 to 0.015 in. (0.013 to 0.038 cm), and it is important that any fastening method not induce stress in the flexure, especially in the webs. A fastening method that meets this requirement is a fillet-welded clamp with a fillet dimension the same as the flexure-disk thickness (see figure). An electron-beam welding process is used, and a new welding fixture interrupts the beam at the webs, as the flexure disks are turned. Flexure disks as thin as 0.010 in. (0.025 cm) have been welded in this

manner. Cross-sectioned samples indicate a satisfactory weld joint. The advantages of this fastening method include:

- Low heat input, thus reducing distortion of the parts.
- Only the clamp and the flexure-disk materials must be matched for welding, thus not affecting the selection of material for the poppet.
- The fastening method is adaptable to very small parts. [In the design for which this method was developed, the outside diameter of the poppet is 0.200 in. (0.508 cm).]

Source: W. A. Gillon, Jr., of
Rockwell International Corp.
under contract to
Marshall Space Flight Center
(MFS-19190)

Circle 2 on Reader Service Card.

VALVE-SEAT SEAL FOR A LATCHING SOLENOID VALVE

Valve-Seat Seal, Latching Solenoid Valve

In an extensive survey of suitable materials, the optimum valve-seat design/material combination, structurally capable of repeated cycling and sustained loads, has been found to be Kel-F-81. Previous applications with Kel-F have been less successful under tensile stresses.

In a new high-pressure, latching solenoid-valve seat (see figure) nearly the entire surface of the Kel-F is encapsulated in metal. Thus, only limited deflection of the material can occur. The valve head, which squeezes the sealing "footprint" of the Kel-F, compresses the material within the confinement of the metal enclosure; and no tensile stresses can, therefore, be generated in the Kel-F.

A valve with a pressure-compensating bellows requires that the seat-sealing "footprint" be stable, if all forces are to remain constant. This stability is achieved after about 50 burn-in cycles, and is retained for over 2000 cycles.

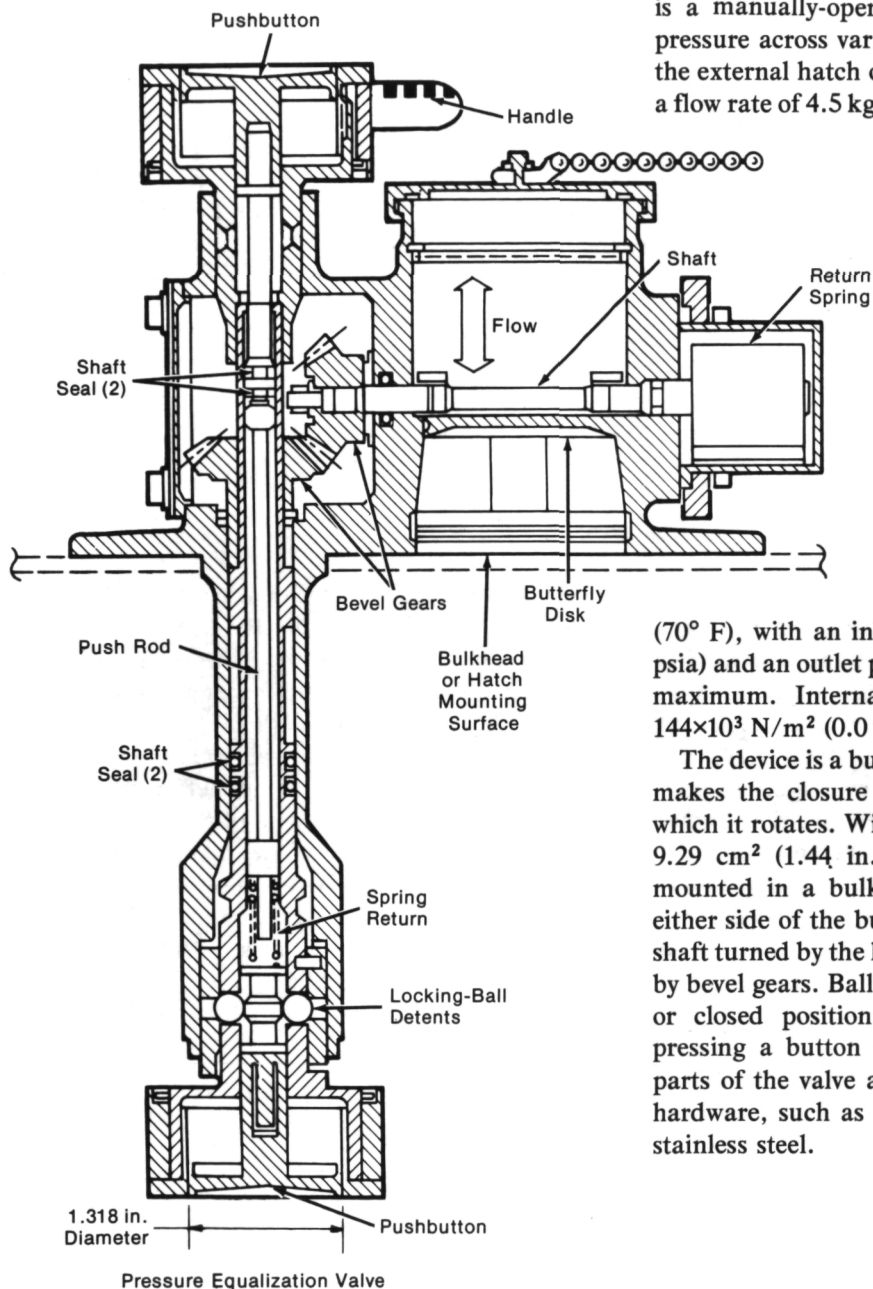
A valve-seat ring seal is used to seal the seat to the valve body. An increased area of seat/seal contact improves valve-seat encapsulation in this design, without the use of an O-ring.

Source: R. J. Dannenmueller and
J. F. Schuessler of
McDonnell Douglas Corp.
under contract to
Marshall Space Flight Center
(MFS-22306)

Circle 3 on Reader Service Card.

DUAL-PUSHBUTTON PRESSURE-EQUALIZATION VALVE

The pressure-equalization valve shown in the figure is a manually-operated valve, designed to equalize pressure across various compartment bulkheads and the external hatch of an airlock. The valve maintains a flow rate of 4.5 kg/min (10.0 lb/min) of air at 294 K



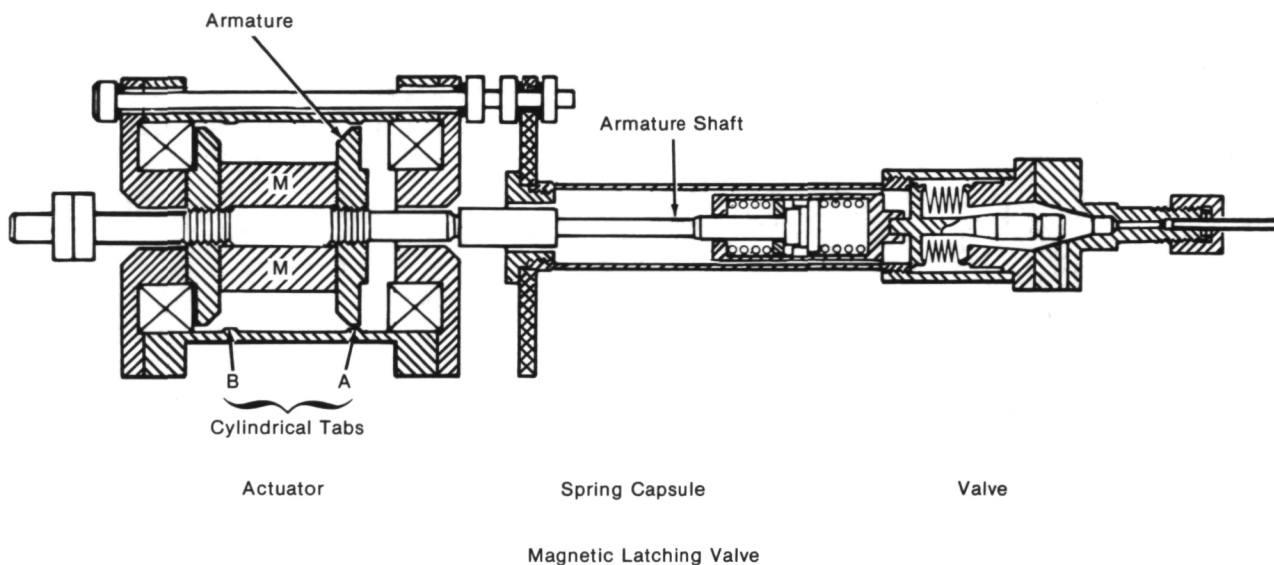
(70° F), with an inlet pressure of $35 \times 10^3 \text{ N/m}^2$ (5.0 psia) and an outlet pressure of $18 \times 10^3 \text{ N/m}^2$ (2.6 psia) maximum. Internal operating pressure is 0.0 to $144 \times 10^3 \text{ N/m}^2$ (0.0 to 6.2 psig).

The device is a butterfly type, in which the disk that makes the closure is offset from the shaft around which it rotates. With a minimum effect flow area of 9.29 cm^2 (1.44 in.²), the valve is designed to be mounted in a bulkhead. It may be operated from either side of the bulkhead by turning a handle. The shaft turned by the handle is coupled to the valve stem by bevel gears. Ball detents hold the valve in an open or closed position; the detents are unlocked by pressing a button on either handle. The principal parts of the valve are made of aluminum alloy; and hardware, such as screws and washers, are made of stainless steel.

Source: J. F. Schuessler of
McDonnell Douglas Corp.
under contract to
Marshall Space Flight Center
(MFS-22303)

Circle 4 on Reader Service Card.

MAGNETIC LATCHING VALVE



A latching, fast-acting two-port poppet valve has been developed for gas chromatograph-mass spectrometer combinations. It has a positive actuation time on the order of a few hundredths of a second and a static force that holds the valve in position at all times. The valve has a linear, bistable magnetic actuator which utilizes a permanent magnet to hold the poppet in position and requires electrical power only to shift the valve poppet from one position to the other.

The device, shown in the diagram, consists of three distinct subassemblies: a valve, a spring capsule, and a magnetic actuator. The valve is of conventional two-port design; the poppet stroke is about 1.5 mm (0.060 in.), and leakage and operational friction are kept to a minimum by use of a bellows instead of a packing gland.

The spring capsule is located in a coupling barrel, and it can move freely within the barrel; the capsule itself is rigidly attached to the valve poppet stem. An extension of the armature shaft acts as a piston within the capsule and compresses either of two springs. The springs are attached to the two ends of the capsule, but not to the armature shaft; in fact, at the center of armature travel, the piston end of the armature shaft extension has an unloaded clearance of about 0.51 mm (0.020 in.). Armature motion is restricted so that either spring is compressed 0.25 mm (0.01 in.) when the poppet is fully open or closed. Additionally, the springs are selected so that they exert a force of about 1.6 kg (3.5 lb) when compressed to this extent.

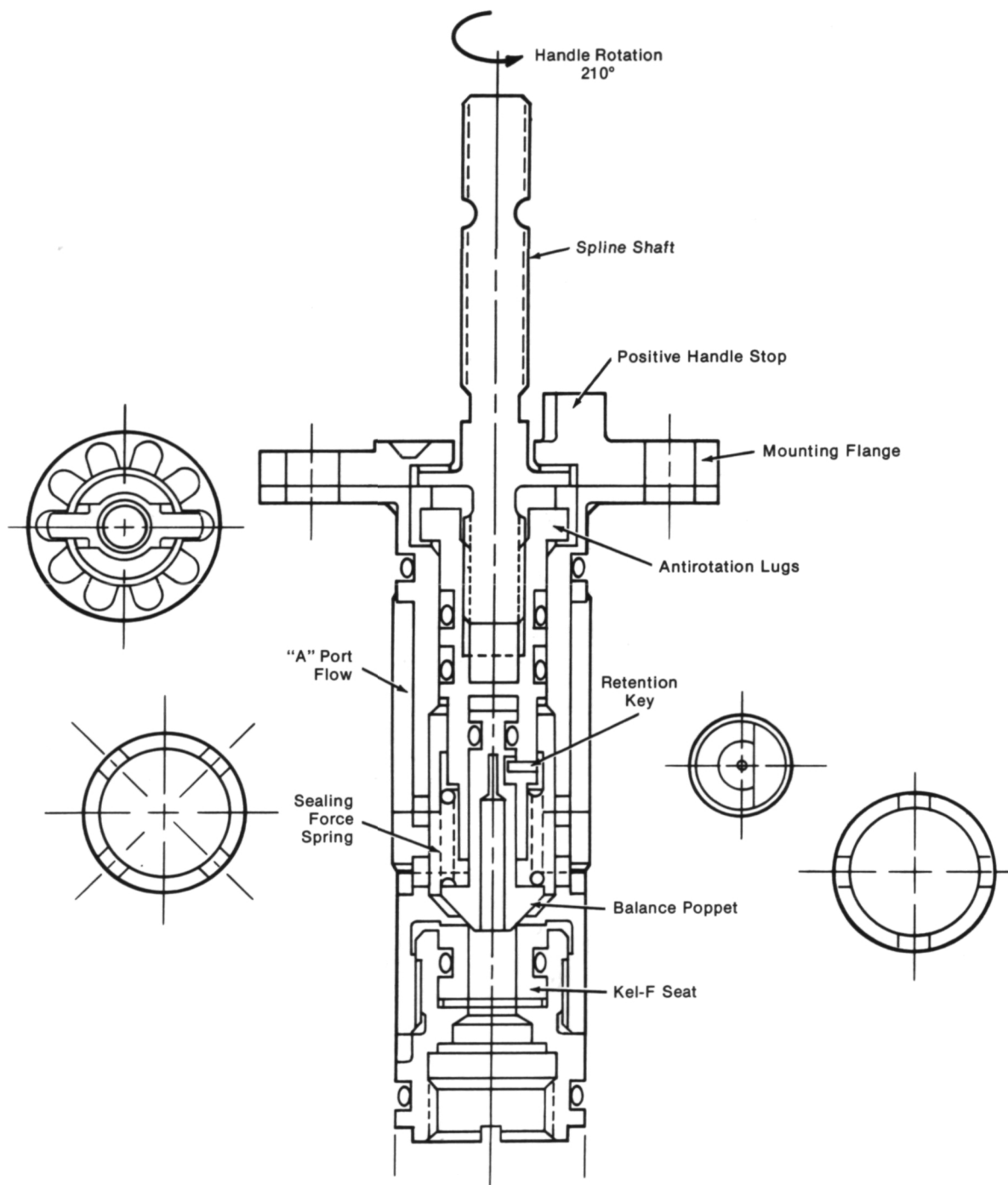
The actuator consists of a cylindrical, axially symmetric armature of soft iron (or other material of high permeability and low coercive force) with a permanent magnet of high coercive force, and a cylindrical stator of soft iron with end caps of the same material. The actuator shaft is made of nonmagnetic metal. Two actuating solenoids are mounted in the end caps. In the diagram, the armature is shown at the limit of its travel and at one of its two bistable positions. The armature will remain at either end of the stator enclosure, because of the attraction between the permanent magnet in the armature and the soft iron caps of the stator. When the armature end is in contact with the end cap, the basic flux path is such that the majority (88 percent) of the flux lines pass through the contact interface parallel to the armature shaft and return via the stator shell through cylindrical tab A. The magnetic holding force is of the order of 2.7 kg (6 lb); thus, since the spring in the spring capsule exerts a return force of 1.6 kg (3.5 lb), the poppet is held open (or closed) by a net force of 1.1 kg (2.5 lb).

The actuator is changed over to the other bistable position by energizing the solenoids to an extent that

the effective flux in the armature-stator system is decreased, and the return force exerted by the spring capsule can move the armature away from one end cap. The solenoids are energized in series; one coil bucks the magnetic flux in the end cap nearest the armature and the other coil establishes, in the opposite end cap, a flux which can attract the armature magnet. When the solenoids are energized, the capsule spring accelerates the armature away from tab A, breaking the flux path which held the armature against the left end cap; the armature rapidly moves towards the right end cap and establishes a new flux path through tab B. When power to the solenoids is removed, the armature remains locked in its new position.

Source: Joseph M. Conley of
Caltech/JPL
under contract to
NASA Pasadena Office
(NPO-11790)

Circle 5 on Reader Service Card.

DUAL-DIRECTION FLOW-BALANCED POPPET

A hand-operated valve [2.6 J (15 in.-lb)] with 210° rotation imparts linear axial motion to the valve stem through a screwjack mechanism. The stem carries a preloaded balanced poppet which closes against a simple plastic seat.

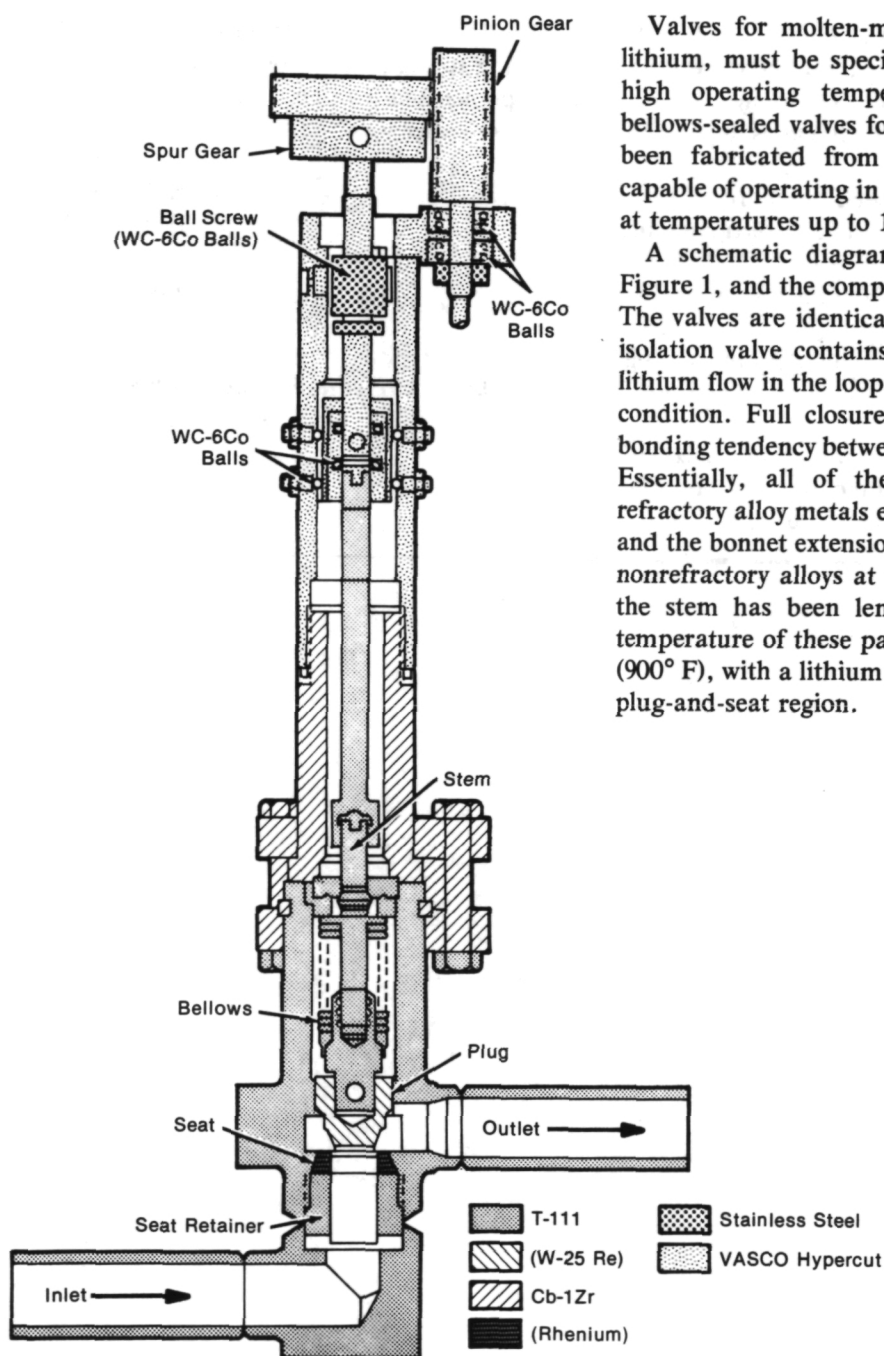
Some features of the valve (see figure) are:

- a. Positive stops which prevent overtightening against the seat;
- b. The nonscrubbing action of the linear-movements system;
- c. A balanced poppet design which prevents plug loads from overstressing the valve seat when pressure is reversed;
- d. Simple and lightweight parts which are inexpensive and can be manufactured on the spot [the valve and handle weigh 118 g (0.26 lb)];
- e. A wear-compensating feature in the valve followup of the spring-loaded poppet, and;
- f. A poppet that can be altered to a one-directional valve (either way).

Source: D. P. Musso of
Hamilton Standard
under contract to
Johnson Space Center
(MSC-12420)

No further documentation is available.

HIGH-TEMPERATURE VALVES FOR LIQUID-METAL SYSTEMS



Valves for molten-metal systems, such as liquid lithium, must be specially constructed to withstand high operating temperatures. For this purpose, bellows-sealed valves for metering and isolation have been fabricated from refractory alloys. They are capable of operating in molten lithium for 5000 hours at temperatures up to 1310 K (1900° F).

A schematic diagram of the valves is shown in Figure 1, and the components are shown in Figure 2. The valves are identical except that the plug of the isolation valve contains a bypass hole, to maintain lithium flow in the loop system even in the full-closed condition. Full closure is required to evaluate the bonding tendency between the valve plug and the seat. Essentially, all of the valve parts are made of refractory alloy metals except the bearings, the gears, and the bonnet extension. In order to maintain these nonrefractory alloys at safe operating temperatures, the stem has been lengthened to ensure that the temperature of these parts would be less than 755 K (900° F), with a lithium temperature of 1310 K in the plug-and-seat region.

Figure 1. Final Design of the High-Temperature Alkali-Metal Valve

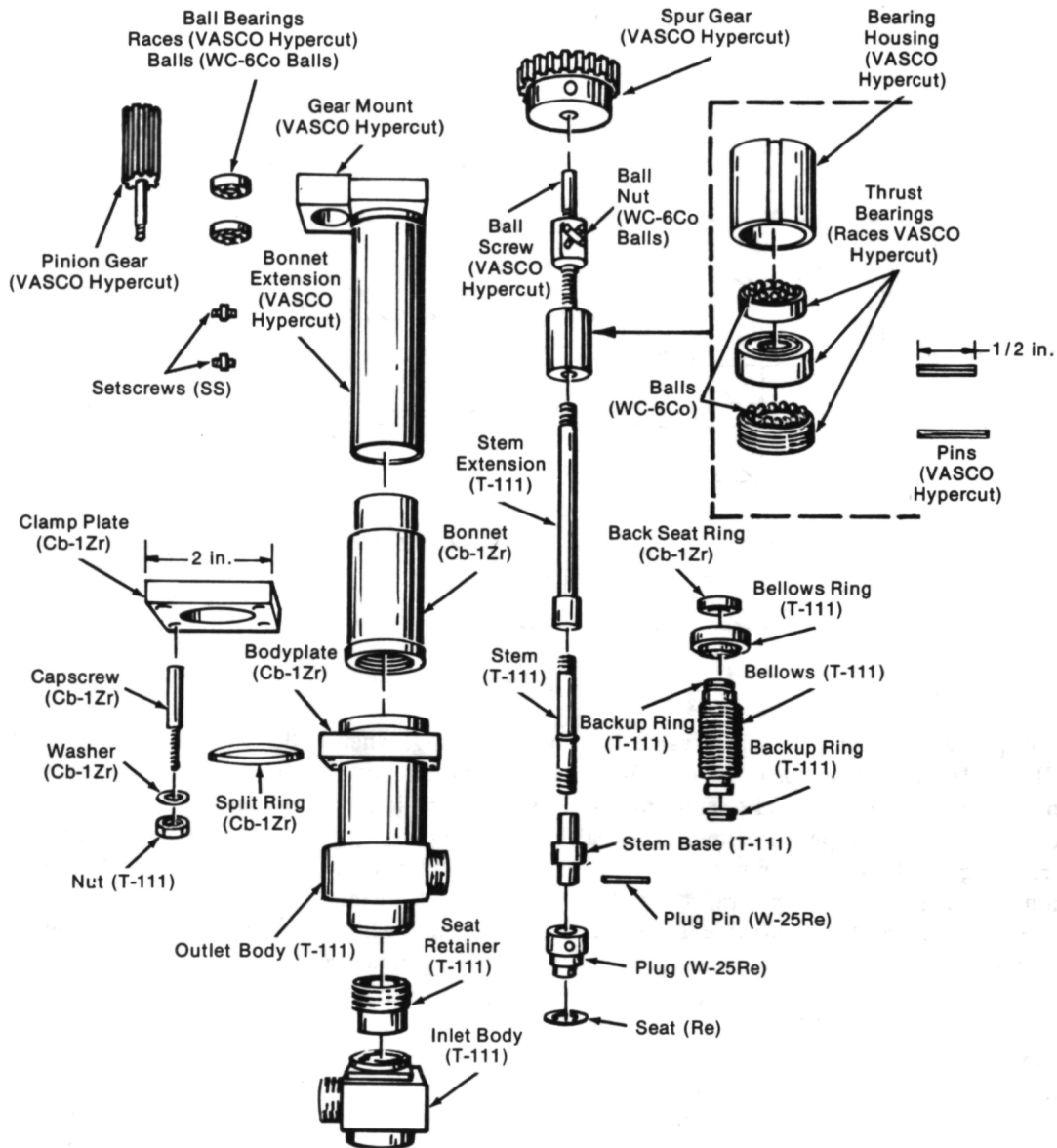
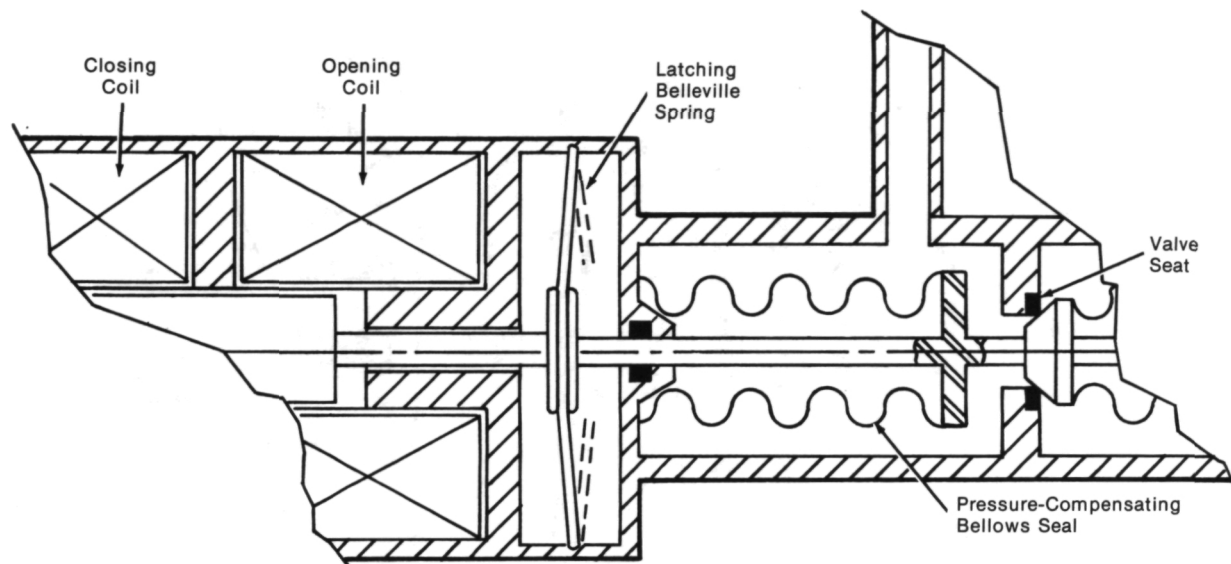


Figure 2. High-Temperature Alkali-Metal Valve Parts Before Assembly

The valves have been operated in a vacuum of 10^{-9} torr. The isolation valve was operated for several cycles, with hold times between cycles, at temperatures of 920 K, 1030 K, 1140 K, 1250 K, and 1310 K (1200°, 1400°, 1600°, 1800°, and 1900° F, respectively), for a total of 95 operations. The torque to open and close the valve during each cycle was measured and did not increase noticeably. The metering valve was operated successfully to one-fourth travel for 500 cycles and to three-fourths travel for 100 cycles.

Source: J. Holowach and
R. W. Harrison of
General Electric Co.
under contract to
Lewis Research Center
(LEW-11253)

Circle 6 on Reader Service Card.

LATCHING SOLENOID VALVE [BELLEVILLE LATCH CONCEPT]

Latching Solenoid Valve

A high-pressure latching solenoid valve incorporates Belleville springs to provide the forces for latching open and seating. The concept permits reduced weight. With proper refinement, the valve is a fast-reacting highly reliable unit.

As illustrated, the valve incorporates two Belleville springs, stacked in parallel, to provide the seat-sealing force required to meet specification leakage at 4.5×10^6 N/m² (4500 psi), and to provide the latch-open/closed forces required to maintain position stability. The very high spring-rate increase, caused by the action of the high pressure on the pressure-compensation bellows, requires a relatively strong spring, having both negative and positive high spring rates.

The force-deflection relationship of a Belleville spring with an appropriate h/t (cone height-to-thickness) ratio, to allow snap-through, has the required spring rates. By limiting the Belleville deflection as shown, a fairly linear spring rate can be obtained. The

spring, when deflected to a certain point, will snap through center and require a negative loading to return it to its original position.

This spring system is lightweight and is compatible with the shape of the valve body. Required forces and travel distances are compatible with a Belleville spring, while acceptable stress levels are maintained. The primary advantage of the concept, however, is its simplicity.

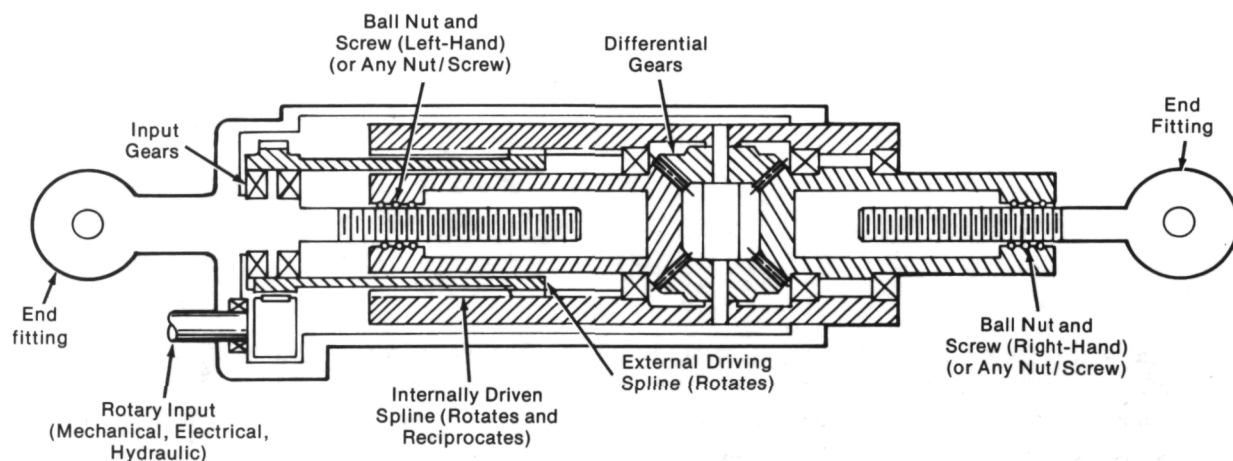
Source: R. J. Dannenmueller and
J. F. Schuessler of
McDonnell Douglas Corp.
under contract to
Marshall Space Flight Center
(MFS-22318)

Circle 7 on Reader Service Card.

Section 2.

Machinery, Equipment, and Mechanical Devices

REDUNDANT SCREWJACK



Screwjacks used as actuators on aircraft flap systems, and in other critical applications, may be subject to failures. These failures occur in the existing double-nut and telescoping-type screwjacks when any of the nut-screw assemblies jam. Redundancy in such systems is provided by a redundant screwjack that uses differential gears to drive either one of the nut-screw assemblies, in the event that the other jams.

The redundant screwjack (see figure) utilizes input gears to drive a rotary external spline which, in turn, meshes with and drives an internal spline. The internal spline is designed to rotate and reciprocate with the external one. The internal spline also supports the spider input to the differential gears.

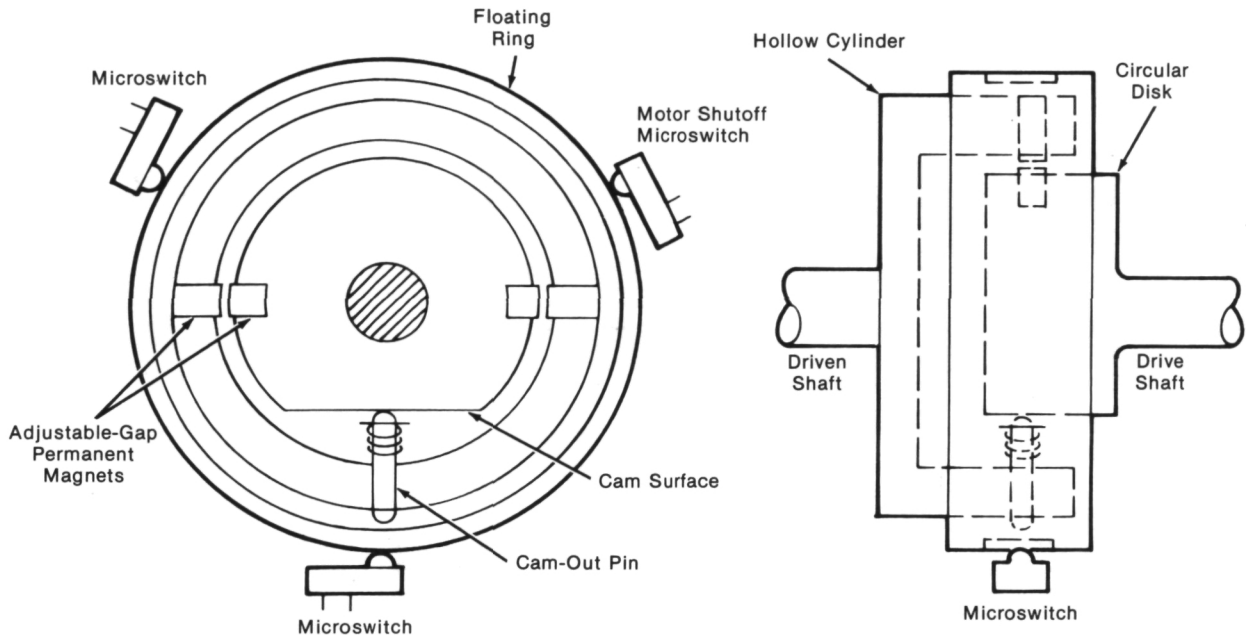
These gears rotate the right-hand and left-hand ball nuts which move the left-hand and right-hand screws, extending or retracting them. The screws do not rotate but are firmly attached to the structure.

If either nut-screw combination jams, the differential gears will drive the other combination at twice its normal rate with no loss in overall performance.

Source: R. W. Benjamin of
Rockwell International Corp.
under contract to
Johnson Space Center
(MSC-19200)

No further documentation is available.

ELECTROMECHANICAL TORQUE-LIMITING COUPLING



Electromechanical Torque-Limiting Coupling

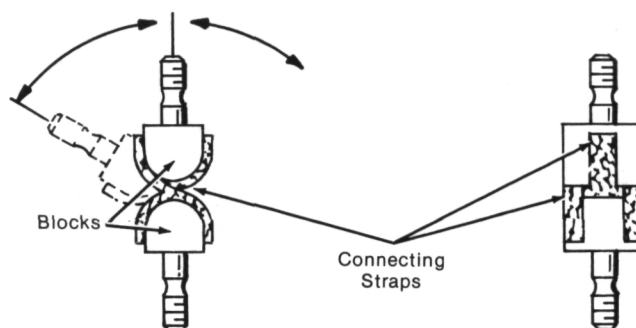
An adjustable-strength magnetic coupling for a drive shaft automatically turns off the driving motor when a preset torque is exceeded. The coupler is shown in the figure. The end of the drive shaft is a thick circular plate with a cam surface. This plate is coupled magnetically to a hollowed cylinder surrounding it; the hollowed cylinder is affixed permanently to the driven shaft.

When there is no torque, the driven and drive shafts rotate together. When the torque on the driven shaft exceeds the force of the magnets, slippage occurs and the circular plate rotates independently of the hollowed cylinder. This change in the relative positions of the plate and the cylinder causes the plate to depress a cam-out pin in the cylinder. The pin then pushes out a floating ring that surrounds the coupling. Three microswitches, connected in series to the motor, surround the floating ring; when the ring is pushed out, it presses at least one of the switches and turns off the motor.

The amount of torque allowed the driven shaft may be adjusted by moving the outer magnets with a setscrew. In an alternative version of the coupler, the magnets are replaced with leaf springs and the torque is controlled by varying the spring size. The cam pin is spring loaded, so it will not be activated inadvertently by centrifugal force; and the floating ring is held in place by three small fingers that allow radial but not axial motion.

Source: Merton Clevett and
Bruce McKown of
Martin Marietta Corp.
under contract to
Langley Research Center
(LAR-10971)

No further documentation is available.

FRICTIONLESS ROLL-FLEX PIVOT

Frictionless Roll-Flex Pivot

The frictionless roll-flex pivot shown in the figure consists of two blocks and three connecting straps. The adjacent or bearing edges of the blocks are arcs of a circle. The straps are formed to match the contoured end of the block as closely as possible. Rivets, screws, or welds secure the end of the straps to the blocks.

Rotational movement is accomplished by flexing or unwinding of the straps. Thus, the resistance to turning is a direct function of the resistance in the strap material, i.e., the stronger the material (e.g., spring steel), the greater the resistance. However, when the loads connected to the blocks rotate, they do not have to overcome additional friction forces in the pivot.

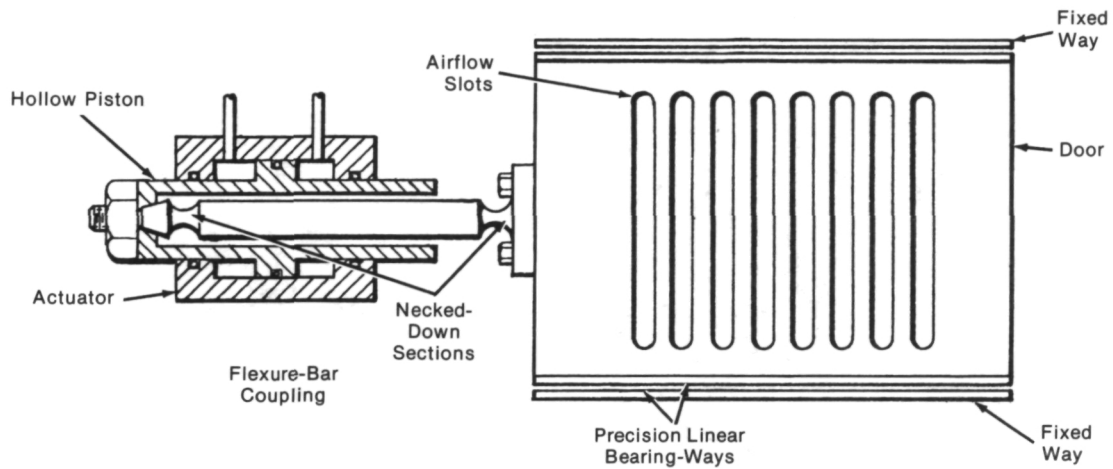
The pivot may be made of a variety of metallic or nonmetallic materials. Also, by using blocks of different diameters, the movement can be amplified or attenuated.

This inexpensively fabricated pivot system could be useful in devices requiring low friction, such as mechanical load transfer systems and oceanographic equipment.

Source: J. G. McCoy of
TRW Systems Group
under contract to
Johnson Space Center
(MSC-12300)

No further documentation is available.

MECHANICAL COUPLING FOR HIGH-CYCLIC LOADING



Flexure-Bar Coupling Used in High-Speed Hydraulic Positioning Servo

A mechanical coupling has been designed for a high-speed, hydraulic positioning servo system, in which both the actuator and the load are required to move with precise linear motion. In this case, the actuator is a piston, and the load is a slotted-plate valve used in a supersonic jet-engine inlet (door) bypass system. If a solid coupling without flexures is used in this application, any slight misalignment will create side forces on the actuator and door bearings, causing high frictional loads accompanied by rapid deterioration and failure. A two-piece ball-and-socket linkage between the two parts will also fail, due to backlash caused by high acceleration forces. Therefore, the coupling has to meet the following physical requirements:

- a. High reliability under high-cyclic loads,
- b. Zero backlash,
- c. Low mass,
- d. Close spacing between actuator and load,
- e. Allowance for misalignments and deflections without causing high side loading on components, and
- f. High stiffness in the direction of motion.

These requirements are met by a one-piece, cylindrical flexure-bar coupling (see figure) with necked-down regions at each end to form flexures that allow for small misalignments between the actuator and the load. The flexure-bar coupling has low stiffness in all directions, except parallel to the load; it introduces no backlash, and has sufficient axial strength for high-cyclic loading.

The coupling is installed inside a hollow piston rod; one end is fastened to the piston rod, and the other end is bolted to the valve plate. The coupling material is 18 percent Ni 300 maraging steel, which has been fully heat treated. The necked-down regions are contoured elliptically and the surface is machined to a fine finish (32 rms).

With this design, no problems have been encountered from misalignment. The coupling has been tested, attached to the door weighing about 4 kg (9 lb), oscillated through a stroke of 0.25 cm (0.1 in.), producing a peak load of about 1360 kg (3000 lb). Twenty-four hours of operation over a frequency range from 5 to 200 Hz produced no perceptible wear on either the actuator or the load.

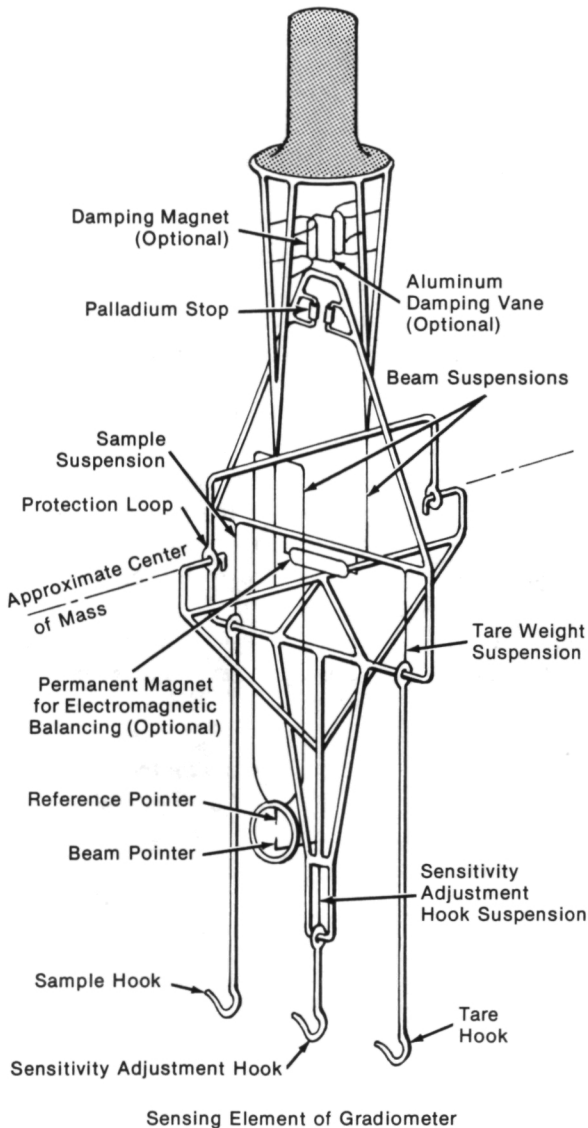
The following documentation may be obtained at cost from:

National Technical Information Service
Springfield, Virginia 22151

Reference: TN-D-2812 (N73-25097), Improved Design of a High-Response Slotted-Plate Overboard Bypass Valve for Supersonic Inlets

Source: Miles O. Dustin and
Oral Mehmed
Lewis Research Center
(LEW-11690)

IMPROVED LABORATORY GRADIOMETER CAN BE A FIELD SURVEY INSTRUMENT



Improvements made to a quartz gradiometer to minimize or eliminate disturbing effects from known error sources permit a sensitivity of $\pm 1 \times 10^{-9} \text{ sec}^{-2}$ or better and a measuring accuracy of $\pm 5 \times 10^{-9} \text{ sec}^{-2}$. This performance is considered adequate for application of the gradiometer as a field survey instrument.

The sensing element of the gradiometer is a sensitive fused-quartz balance. The illustration shows the basic configuration of the element.

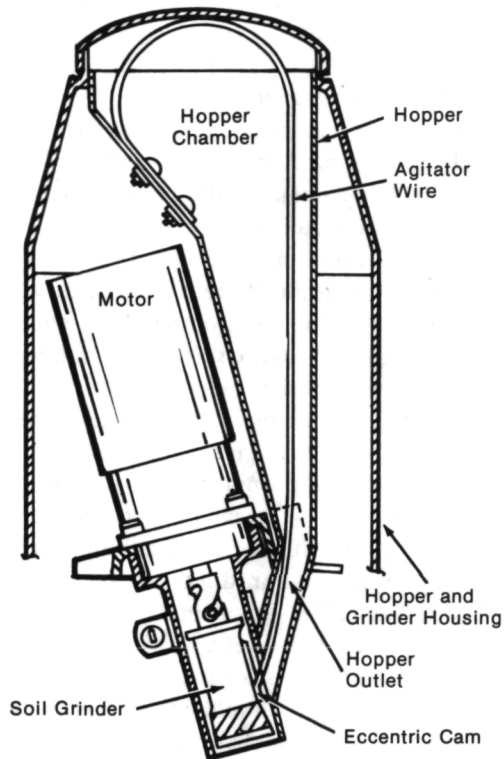
Two equal 10-gram (0.35-oz) balance weights are suspended from the gradiometer element. The two weights hang nearly in the same vertical line, with one weight a known distance below the other. The vertical gravity gradient creates a differential force between the two weights which causes the balance arm to tilt through a deflection angle. This deflection angle is proportional to the gravity gradient, and once calibrated is a measure of the gradient. Direct optical scales or capacitor-transducer sensors measure the deflection angle. Varying a small weight on the center hook adjusts the sensitivity.

The increasing need for raw materials and natural resource exploration should make this innovation of interest in mineralogical surveying applications.

Source: L. G. D. Thompson, M. H. Houston,
D. A. Rankin, and E. M. Yavner
General Oceanology, Inc.
under contract to
Johnson Space Center
(MSC-13980)

Circle 8 on Reader Service Card.

A DEVICE FOR DECCLOGGING HOPPERS



It is common for hopper outlets to become clogged with fine particles. Although there are several general solutions to this problem, they fail when very fine particles (less than $200\ \mu$) are to be delivered. For instance, conventional vibration declogging only serves to pack the material further and to make the clogging worse.

The problem is solved by having a thin wire, which can be intermittently agitated from within, pass through the hopper inlet. This disturbs the particles without allowing them to pack together.

In the particle application illustrated (see figure), the wire is agitated by means of an eccentric cam on the shaft of a soil grinder. However, any means of internal agitation would be sufficient. The figure represents the side elevation of a soil grinder with a hopper attached. The agitator wire is anchored within the upper portion of the hopper and passes down through its outlet, to be agitated by an eccentric cam on the shaft of the soil grinder.

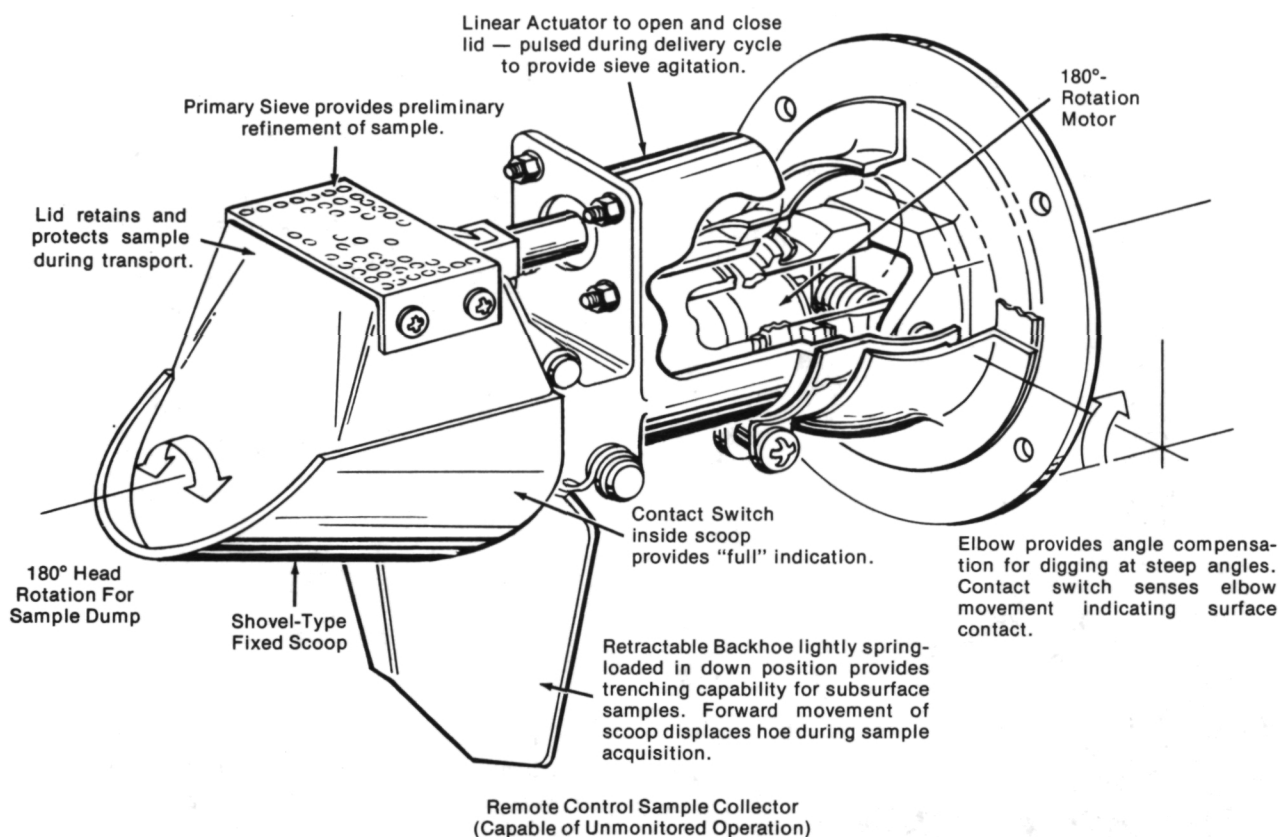
Such a device could be useful whenever fine particles are to be delivered via hopper (e.g., in transporting flour).

Source: James Loomis of
Martin Marietta Corp.
under contract to
Langley Research Center
(LAR-10961)

A Device for Declogging Hoppers

Circle 9 on Reader Service Card.

PROGRAMABLE REMOTE-CONTROL SOIL SAMPLER



A soil sampler has been developed as a programable remote-control device for use on Mars. It is capable of taking samples from both the surface and from a few inches below; furthermore, it lifts the sample into a container for collection. This sampler has possible application wherever blind sampling is required (e.g., with hazardous materials such as radioactive waste). In addition, it can be adapted readily for use underwater, thus alleviating the need for costly camera equipment and lighting.

The sample collector (see figure) is mounted on an extendable boom. The boom can be lowered until the elbow contact switch indicates surface contact. At this point, the lid is opened, and the collector is ready for sample acquisition. If a subsurface sample is desired, the boom is retracted, and the backhoe digs a trench from which the sample may be taken.

To take a sample, the boom is extended, driving the open scoop into or along the surface until a full indication is received from the contact switch in the back of the scoop. Then the lid is closed, the boom is

lifted, and the whole is rotated 180°. At this point, the sample is delivered through a primary sieve. The same linear actuator that closes the lid is used to agitate the sieve, through intermittent pulsing. After a time sequence or sample-received indication, the scoop is rotated to the upright position. Then it is deployed to a dump position at a predetermined down angle. The lid is cycled open and closed to empty the scoop.

The major novel feature found in this design is the elbow-type gimbal at the boom interface. It serves to reduce the effective digging angle range by providing angular compensation for digging at steep angles.

Source: J. Timbrook of
Martin Marietta Corp.
under contract to
Langley Research Center
(LAR-10832)

No further documentation is available.

A TECHNIQUE FOR CENTERING LOCKWASHERS ON HIGH-SPEED ROTATING EQUIPMENT

Conventional lockwashers and locknuts frequently contribute to unbalance in machinery that rotates at high speeds. This is particularly troublesome in the reassembly of machinery. The washers cannot be centered precisely, due to the clearances between the insides of the washers and outsides of shafts. The

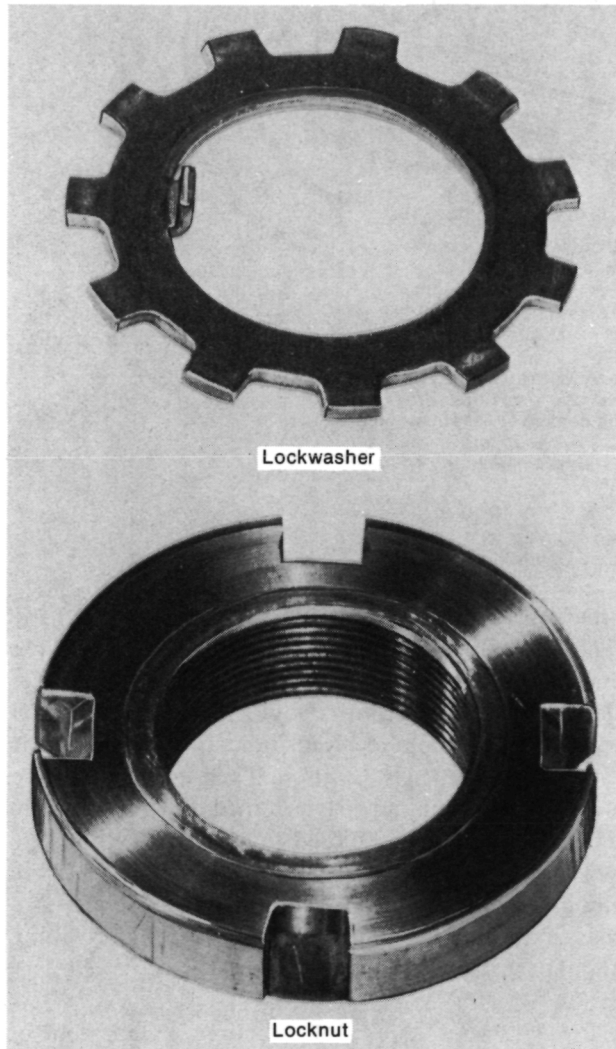


Figure 1. Lockwasher and Locknut for High-Speed Rotating Equipment

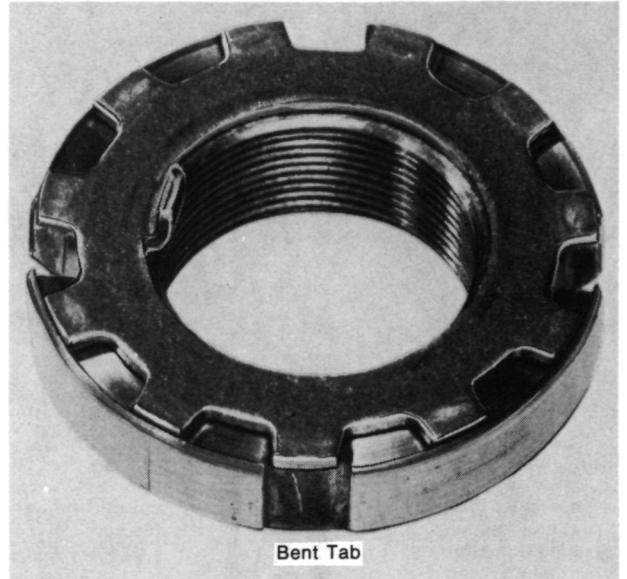


Figure 2. Lockwasher in Place

problem is solved by machining close-fitting recesses in the locknuts to accept and center the lockwashers. The washers are then locked with tabs bent into slots in the locknuts.

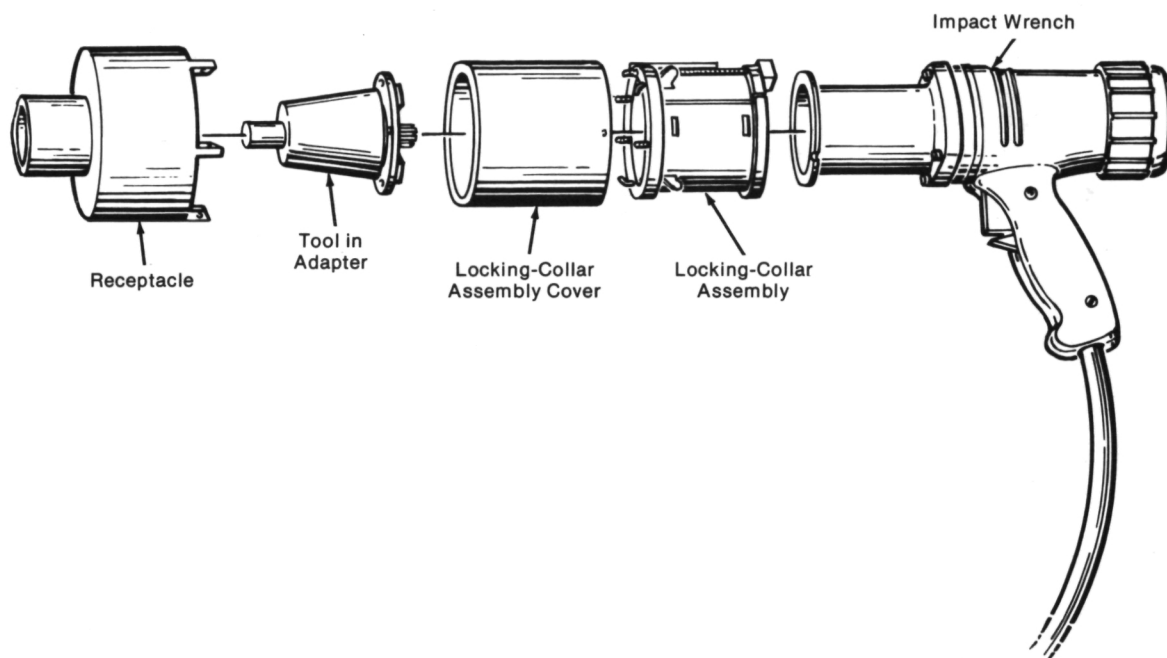
Figure 1 shows a concentric recess machined into the back surface of the locknut to accept and center the lockwasher. The lockwasher is placed on the shaft, the locknut is threaded over it, and one tab is bent into the locknut slot (Figure 2).

This technique alleviates problems in both the static and dynamic balancing of high-speed rotating equipment which is reassembled repeatedly; the lockwasher can be replaced in the same relative position, and off-center placement is minimized.

Source: Harry J. Cole
Lewis Research Center
(LEW-11223)

No further documentation is available.

PRESSURE-ACTIVATED TOOL RELEASE AND LOCKING MECHANISM



Mechanical Elements of the Tool-Exchange System for a Remote Manipulator

A mechanism that gives singlehanded toolfitting and release capability to a pneumatic wrench will be very helpful to handicapped workers, to underwater manipulators, and in automated systems where the time for a cybernetic to change tools is less than the time for new work to move into position. The figure shows the elements for the tool-exchange system for remote-control application.

In operation, the remote manipulator grasps the impact wrench and thrusts it into the receptacle. This motion is transferred to the locking-collar assembly by contact of the slide with the outer rim of the receptacle, engaging the tool to the wrench. On retraction of the wrench from the receptacle, the tool is locked, aligned, and ready for use. After use, the wrench is again inserted into the receptacle, and the locking-collar assembly is actuated to release the tool. After retraction, the wrench is ready to receive another tool for another operation.

The double action in one motion, i.e., locking and releasing, is made possible by the locking-collar assembly through the unique cam-and-pawl arrangement shown in the drawing. A spring plunger,

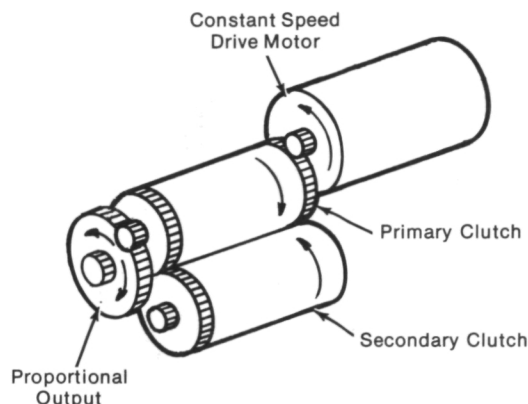
mounted in the locking collar, indexes in a hole in the tool adapter to prevent it from rotating when the tool is in operation. A second spring plunger, mounted in the nose of the receptacle, snaps into a groove on the tool adapter, holding it in the receptacle against vibration and frictional forces. Four mounting tongs support the receptacle by springs, which allow an exchange of the tool adapter even when the wrench and the receptacle are not aligned nominally for insertion. The tongs act as guides for alignment.

Other uses for this tool-exchange method, not mentioned above, are remote-control manipulations where radiation hazards are present, any hazardous working conditions where only one hand is free to change tools, and in assembly lines.

Source: R. E. Marlow of
Sperry Rand
under contract to
Marshall Space Flight Center
(MFS-22283)

Circle 10 on Reader Service Card.

MAGNETIC PARTICLE CLUTCH CONTROLS SERVO SYSTEM



TYPICAL DRIVE TRAIN

The two counter-rotating clutches provide two-directional control. The drive motor powers the counter rotating clutches, whose output provides proportional control to the common output gear.

Magnetic particle clutches provide an alternate means of driving low-power rate or positioning servo systems (up to 0.2 kW for intermediate duty cycles). There are several advantages in the use of a magnetic clutch as compared to the more commonly employed servo motors.

Magnetic clutches may be used over a wide variety of input speeds, 1000 to 10,000 rpm, and are of use for many slip speed ranges. The torque-to-current response remains constant over a wide range of clutch input speeds. This constant torque response is extremely useful when operating at reduced primary drive speeds, as might occur when emergency conditions in an aircraft cause reduced motor

voltages. Another important feature of a magnetic clutch in a servo system is its comparatively low weight. Clutches have been designed to weigh as little as 0.675 kg (1.5 lbs) for a 0.2-kW unit.

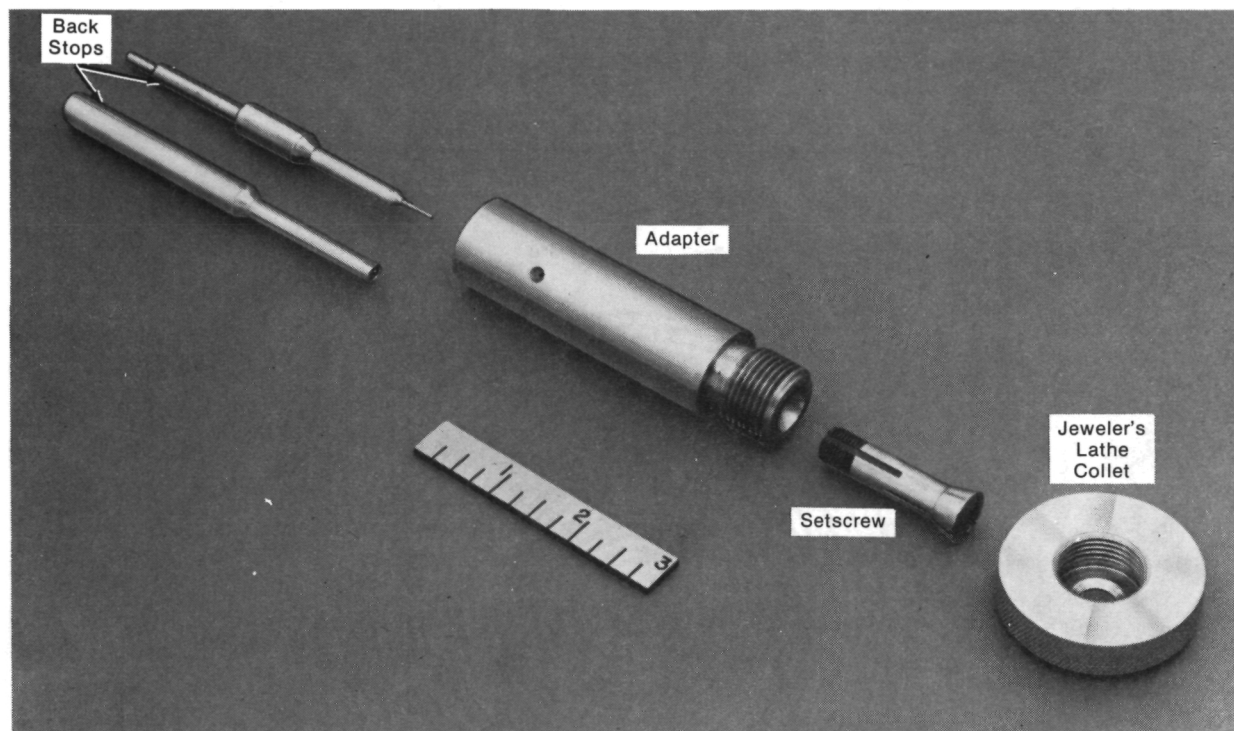
The power drain is very good, with an overall motor/clutch efficiency greater than 50 percent, and the gain of the clutch is close to linear, following the hysteresis curve of the core and rotor material. With the proper selection of core and rotor material, hysteresis may be kept to within 4 or 5 percent of the saturation level.

The figure shows how a magnetic clutch can be used in a typical rotary positioning servo. In a magnetic particle clutch, a current is applied to a coil winding to produce a magnetic field that aligns the particles in a chain. Through this chain, an output torque is developed in proportion to the applied current.

To design the proper clutch for a given servo system, one must know the appropriate electrical-mechanical transfer function and heating profile for the clutch over the desired operating range. Information is available on these and other factors of interest in the design of mechanical particle clutches for servo systems.

Source: P. B. Fow of
Rockwell International Corp.
under contract to
Johnson Space Center
(MSC-17136)

Circle 11 on Reader Service Card.

JEWELER'S COLLET ADAPTER FOR TOOLROOM LATHE

Jeweler's Collet Adapter for Toolroom Lathe

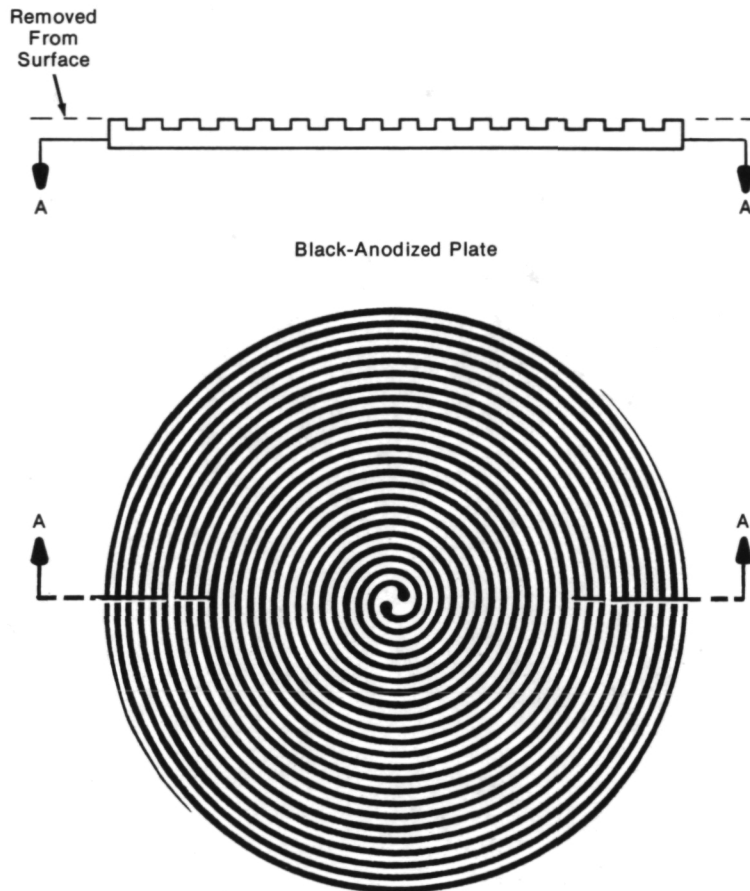
In making small (under 0.6 cm) parts on a toolroom lathe, it is difficult to maintain close tolerances in length and concentricity. An adapter for a jeweler's-lathe collet, with an internal backstop, improves concentricity and permits parts to be made within tolerances of 0.0025 cm (0.001 in.).

The figure shows two backstops that may be used with the collet. These can be made for parts of different diameters and lengths, and are held in place with a set screw. A typical jeweler's-lathe collet is shown at the other end of the adapter.

Source: A. W. Smith of
Rockwell International Corp.
under contract to
Johnson Space Center
(MSC-19246)

No further documentation is available.

SPIRAL MACHINING BY TAPE CONTROL



Spiral Machining by Tape Control

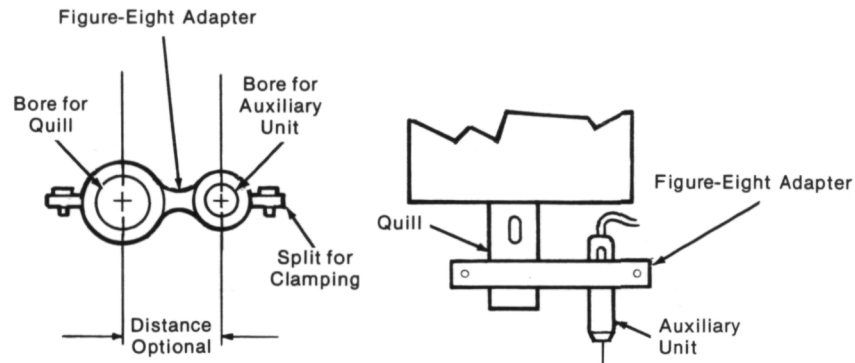
A tape-control method makes it practical to machine spirals with leads which do not match standard milling-machine gearing. The numerically-controlled (N/C) milling machine must have an N/C circular table for one axis. The machine is programmed to give the proper angular movement to the circular table for each 0.025 mm (0.001 in.) of spiral lead. Either the X or the Y axis of the machine is programmed to index in 0.025 mm increments, to give the machine the proper linear motion to match the required spiral lead.

The figure shows the machined spiral artwork for photo-etched spiral antennas. This method requires less setup time and can also be used to make non-linear spirals, with the proper computer programming.

Source: J. Saxty and A. Walch
Goddard Space Flight Center
(GSC-11121)

No further documentation is available.

HIGH-SPEED POWER-DRIVE UNIT ADAPTED TO NUMERICAL-CONTROL DRILL



Adapter (Two Views)

A numerical-control machine has been adapted to hold a high-speed drilling head, which increases the drilling speed at least 15 times over the original-design speed. This unit is used to position the drill and to increase the rpms. It has its own electric or air-driven power source.

The figure shows the unit. A floating-zero facilitates locating the center line of the quill anywhere on a table surface: The center line becomes the point of origin; or with the auxiliary power unit substituted for the machine quill, its center can become the point of origin.

The original machine-quill rpm-unit is placed in the off-position, and the auxiliary unit is attached to the machine quill with a figure-eight adapter, to hold

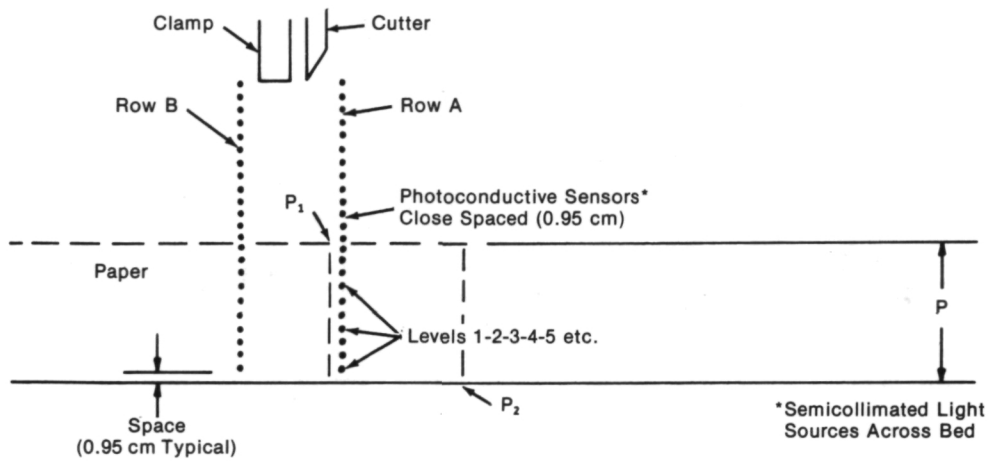
the auxiliary power unit. A programed tape may be added to make the controlled unit do the rest of the work needed, and the drilling is accomplished by the auxiliary power unit.

This adaptation is particularly suitable for small-diameter drill work at high rpm, such as drilling graphite materials for electrical discharge units.

Source: V. J. Nemcek of
Rockwell International Corp.
under contract to
Johnson Space Center
(MSC-15530)

No further documentation is available.

PHOTOSENSOR GUARD FOR PAPER CUTTER CLAMP



Detail A

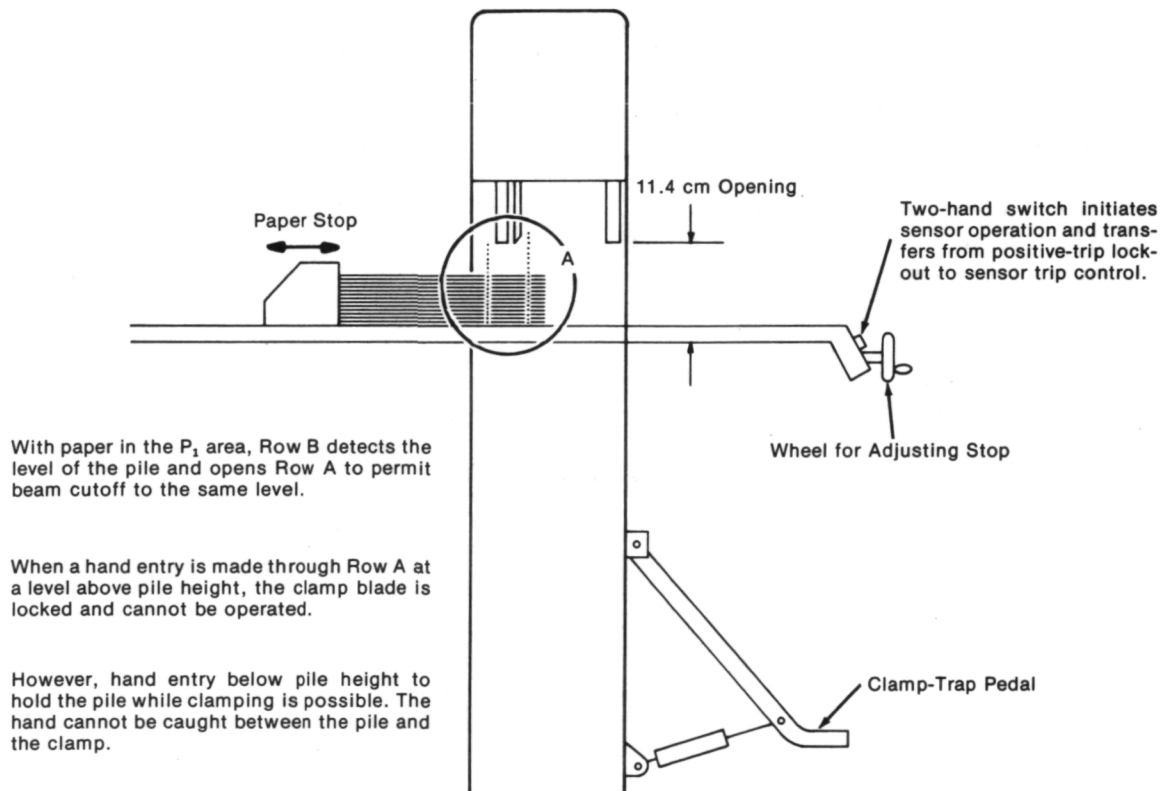


Figure 1. Photosensor Guard for Papercutter Clamp

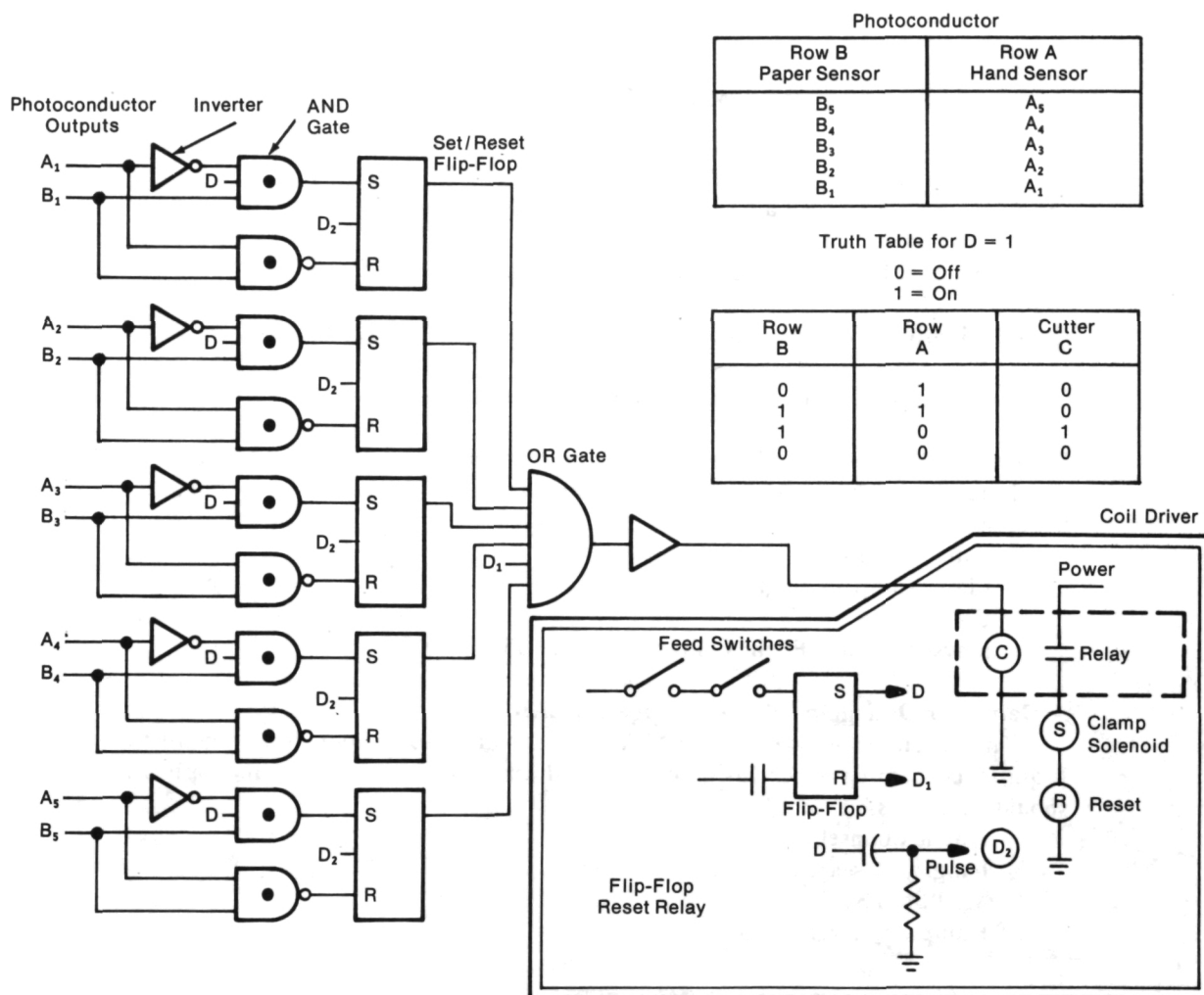


Figure 2. Photoconductor Logic

A double row of photosensors for optical location sensing will protect an operator's hands, should they be in the clamping area when a clamp-trip mechanism is being set. This safety system is illustrated in Figures 1 and 2, and described in the accompanying text.

The operator first uses the handwheel to set back the paper stop. The handwheel must be set far enough back that the paper stack can be brought forward to the exact cutting position. The operator must use his hands in the cutter/clamp area, not only to push the paper but also to hold the pile edges straight. To this point, positive lockout of cutter and clamp is required.

The operator then moves his hands to the double switch, to set the logic circuits for sensor control of the

clamp trip. This ensures that his hands do not cause an inaccurate sensing of the height of the paper stack. As long as the operator's fingers are not above the pile height, he may use his hands to hold the pile against the stop during clamping. Operation of the clamp returns the circuit to the complete lockout mode.

Source: A. D. Vidana of
Rockwell International Corp.
under contract to
Johnson Space Center
(MSC-19303)

No further documentation is available.

Patent Information

The following innovations, described in this Compilation, have been patented or are being considered for patent action as indicated below:

Valve-Seat Seal for a Latching Solenoid Valve (Page 6) MFS-22306

and

Dual-Pushbutton Pressure-Equalization Valve (Page 7) MFS-22303

and

Latching Solenoid Valve [Belleville Latch Concept] (Page 14) MFS-22318

and

Pressure-Activated Tool Release and Locking Mechanism (Page 23) MFS-22283

Inquiries concerning rights for the commercial use of these inventions should be addressed to:

Patent Counsel

Marshall Space Flight Center

Code CC01

Marshall Space Flight Center, Alabama 35812

A Device for Declogging Hoppers (Page 20) LAR-10961

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to:

Patent Counsel

Langley Research Center

Mail Stop 313

Hampton, Virginia 23665

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